Primary Production on the Grand Banks of Newfoundland in April 1984

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Canadian Data Report of Fisheries and Aquatic Sciences

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Les numéros 1 à 25 de cette série ont été publiés à titre de Records statistiques, Service des pêches et de la mer. Les numéros 26-160 ont été publiés à titre de Rapports statistiques du Service des pêches et de la mer, Ministère des Pêches et de l'Environnement. Le nom de la série a été modifié à partir du numéro 161.

Le titre exact paraît au haut du résumé de chaque rapport.

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Fisheries and Aquatic Science No. 579

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Abstract

Irwin, B., Caverhill, C. and Platt, T. 1986. Primary production on the Grand Banks of Newfoundland in April 1984. Can. Data Rep. Fish. Aquat. Sci. No. 579: iv + 49 p.

During the period 9 April to 19 April 1984, primary productivity and other related parameters were measured at a station on the edge of the Grand Banks of Newfoundland. In this report we make available the raw data and some fitted parameters.

Résumé

Irwin, B., Caverhill, C. and Platt, T. 1986. Primary production on the Grand Banks of Newfoundland in April 1984. Can. Data Rep. Fish. Aquat. Sci. No. 579: iv + 49 p.

Pendant la période du 9 avril an 19 avril 1984, la production primaire et plusieurs autres variables ont été mesurée à une station située sur le bord des Grand bancs de Terre neuve. Dans ce rapport nous présentons les données brutes ainsi que les paramétres calculés.

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Introduction

This is the second in a series of data reports giving the results of primary productivity experiments and related nutrient measurements at stations in the open ocean which were occupied for several consecutive days. For this experiment a station was chosen on the southeastern edge of the Grand Banks (Fig. 1). This station was occupied from the 12 April to 16 April. This was a multidiscipline cruise on CSS Hudson coordinated by the Biological Oceanography group of the Marine Ecology Laboratory of the Bedford Institute of Oceanography.

Sampling

All water samples were collected with 30ℓ Niskin bottles. Sampling depths were standard oceanographic depths.

Methods

Productivity

Primary productivity was measured using the ^{14}C method and the oxygen evolution method. The ^{14}C method was essentially as described by Strickland and Parsons (1972). For light saturation experiments 25 µci of sodium bicarbonate ^{14}C was added to 100 mls of sample. A total of 42 light and 2 dark bottles were filled for each light saturation experiment. Incubations were done in temperature controlled incubators illuminated by 250 w tungsten halogen lamps [Gilway Technical Lamp L 7391] (Larsen, in prep). All experiments were incubated for 3 hours.

For in situ experiments, the ^{14}C method and oxygen evolution method were both used. 25 µCi ^{14}C was added to 3 light and 2 dark bottles from each depth for each experiment for the carbon method. For oxygen 3 light,

2 dark and 3 time-zero bottles were filled. The time zero bottles were fixed immediately after filling. The dark bottles - carbon and oxygen - were incubated in a covered temperature controlled tank on deck. All light bottles were redeployed at their respective depths and recovered from 6 to 24 hours later. A maximum of three experiments were run concurrently giving 6, 12 and 24 hour incubation periods. All experiments were deployed within one hour of sunrise. Oxygen bottles were titrated using the micro-Winkler technique of Williams and Jenkinson (1982).

Chlorophyll a

Replicate 100 ml samples were filtered onto 25 mm Whatman GF/F glass fibre filters. Filters were then placed in 20 ml glass vials containing 10.0 mls of 85% acetone. Chlorophyll was extracted for 24 hours at 0°C in the dark. The fluorometric technique of Yentsch and Menzel (1963) as modified by Holm Hansen et al. (1965) was used to estimate chlorophyll and phaeophytin concentrations.

Organic Particulates

Samples for particulate organic carbon and nitrogen were filtered onto precombusted Whatman GF/F filters. Filters were stored frozen for later analysis in methods described in Irwin et al. (1982).

Nutrients

Three inorganic nutrients were routinely measured at all sampled depths. Samples were stored frozen for later analysis using methods described in Irwin et al. (1982).

Incubation and Incident Light

Light intensities in the incubators were measured with a 4 π quantum meter (Biospherical Instruments Model QSL 100). Incident total radiation was measured with a 40 junction black and white pyranometer (Eppley

Laboratories Model 8-48) and Photosynthetically Active Radiation (PAR) with a quantum sensor (Licor model LI190S). The output from both instruments were integrated each hour on a Licor Li 550 printing integrator.

Estimation of Photosynthetic Parameters

Measurements of specific production P^B and irradiance I were used to estimate parameters in the equation of Platt et al. (1981).

$$P^B = P_s \left(1 - e^{-\alpha I/P_s}\right) e^{-\beta I/P_s}$$

P_s (mg C mg chl^{-1} h^{-1}) is the light saturated rate of specific production in the absence of photoinhibition, α (mg C (mg chl^{-1}) h^{-1} w^{-1} m^{-2}) is the initial slope of the PI curve and β (same units as α) is a parameter that characterises photoinhibition. Complete details of the fitting routine are given in Irwin et al. (1982) and a discussion of the mathematical basis for this technique is in Irwin et al. (1980).

Acknowledgements

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In Situ Profiles

Units

Z = depth in meters

P = primary production mg C m^{-3} h^{-1}

Pg = gross production mg O_2 m^{-3} h^{-1}

Pn = net production mg O_2 m^{-3} h^{-1}

Pr = respiration mg O_2 m^{-3} h^{-1}

NO_3, SiO_3 and PO_4 are in mg at m^{-3}

Carbon and nitrogen are in mg m^{-3}

GRAND BANKS 1984

LAT 43°54.3'N LONG. 49°08'W DATE 13.04.84 INCUB. TIME 5.82 HRS

Z	P	OXYGEN			NO_3	SiO_3	PO_4	CHL	CARBON	NITROGEN
		Pg	Pn	Pr						
5	10.02	65.2	58.9	6.2	0.77	0.77	1.30	11.54	821	91
10	3.55	24.5	2.2	22.3	0.75	0.48	0.83	13.36	825	82
15	1.41	22.1	25.4	-3.3	1.14	0.67	0.88	15.17	881	89
20	1.02	4.1	-2.1	6.2	0.76	0.55	0.53	14.01	803	87
25	1.73	11.1	-0.1	11.2	0.36	0.57	0.75	14.40	742	90
30	1.98	4.7	-1.0	5.7	0.77	0.62	0.91	15.56	642	94
35	1.52	1.5	-2.9	4.4	0.48	0.52	0.54	14.40	656	100
40	0.90	-	-	13.0	1.16	1.07	0.94	15.17	594	102

GRAND BANKS 1984

LAT 43°57'N LONG. 49°07'W DATE 14.04.84 INCUB. TIME 6.32 HRS

Z	P	OXYGEN			NO_3	SiO_3	PO_4	CHL	CARBON	NITROGEN
		Pg	Pn	Pr						
5	18.71	59.9	52.0	7.8	0.51	0.37	0.44	11.54	864	85
10	20.09	-	-	11.6	0.29	0.23	0.31	12.84	864	88
15	11.94	40.5	23.7	16.7	0.31	0.21	0.39	12.58	830	77
20	5.54	19.9	18.2	1.7	0.30	0.22	0.38	14.79	694	72
25	2.61	11.8	8.1	3.7	3.00	0.42	0.20	15.05	871	97
30	2.26	8.5	-3.1	11.6	3.06	0.51	0.36	15.17	766	94
35	1.11	2.7	5.5	-2.8	3.24	0.74	0.44	16.86	635	93
40	0.95	10.5	-2.1	12.6	2.02	1.49	0.53	13.62	669	82

GRAND BANKS 1984

LAT 43°57'N LONG. 49°07'W DATE 14.04.84 INCUB. TIME 10.42 HRS

Z	P	OXYGEN			NO_3	SiO_3	PO_4	CHL	CARBON	NITROGEN
		Pg	Pn	Pr						
5	14.24	48.9	58.7	-9.9	0.51	0.37	0.44	11.54	864	85
10	14.16	50.6	53.1	-2.6	0.29	0.23	0.31	12.84	864	88
15	6.93	29.3	36.4	-7.1	0.31	0.21	0.39	12.58	830	77
20	2.62	15.6	25.8	-10.2	0.30	0.22	0.38	14.79	694	72
25	1.19	12.9	18.1	-5.3	3.00	0.42	0.20	15.05	871	97
30	0.84	2.4	9.6	-7.2	3.06	0.51	0.36	15.17	766	94
35	0.95	0.1	17.3	-17.2	3.24	0.74	0.44	16.86	635	93
40	0.88	4.4	13.2	-8.9	2.02	1.49	0.53	13.62	669	82

GRAND BANKS 1984

LAT 43°57'N LONG. 49°07'W DATE 14.04.84 INCUB. TIME 23.82 HRS

Z	P	OXYGEN			NO_3	SiO_3	PO_4	CHL	CARBON	NITROGEN
		Pg	Pn	Pr						
5	6.72	20.6	20.4	0.2	0.51	0.37	0.44	11.54	864	85
10	6.72	17.9	15.8	1.8	0.29	0.23	0.31	12.84	864	88
15	3.40	14.9	6.6	8.3	0.31	0.21	0.39	12.58	830	77
20	1.51	3.1	2.9	0.2	0.30	0.22	0.38	14.79	694	72
25	0.72	0.8	1.0	-0.2	3.00	0.42	0.20	15.05	871	97
30	0.52	0.9	-1.9	2.9	3.06	0.51	0.36	15.17	766	94
35	0.53	3.4	0.7	2.7	3.24	0.74	0.44	16.86	635	93
40	0.32	3.5	-1.9	6.4	2.02	1.49	0.53	13.62	669	82

GRAND BANKS 1984

LAT 43°54.1'N LONG. 49°10'W DATE 15.04.84 INCUB. TIME 5.43 HRS

Z	P	OXYGEN			NO_3	SiO_3	PO_4	CHL	CARBON	NITROGEN
		Pg	Pn	Pr						
5	3.74	12.0	-13.1	25.1	0.29	0.35	0.56	3.45	399	36
10	3.74	13.4	-19.6	32.9	0.00	0.00	0.32	3.15	477	39
15	4.93	25.5	-14.7	40.2	0.00	0.00	0.28	4.17	491	48
20	2.70	5.4	-25.8	31.3	0.00	0.00	0.41	3.93	500	37
25	2.33	3.6	-25.6	29.3	1.18	0.00	0.59	6.24	511	59
30	0.85	4.4	-21.9	26.3	0.29	0.09	0.56	5.63	460	62
35	0.58	8.4	-25.6	34.0	0.96	0.51	0.70	6.38	430	49
40	0.42	6.9	-29.9	36.8	1.93	0.74	0.58	7.44	366	49

GRAND BANKS 1984

LAT 43°54.1'N LONG. 49°10'W DATE 15.04.84 INCUB. TIME 9.90 HRS

Z	P	OXYGEN			NO_3	SiO_3	PO_4	CHL	CARBON	NITROGEN
		Pg	Pn	Pr						
5	3.05	18.1	-2.4	20.5	0.29	0.35	0.56	3.45	399	36
10	2.89	15.5	-6.0	21.5	0.00	0.00	0.32	3.15	477	39
15	3.40	11.4	-5.6	17.0	0.00	0.00	0.28	4.17	491	48
20	1.93	6.5	-16.1	22.6	0.00	0.00	0.41	3.93	500	37
25	1.42	10.7	-15.0	25.7	1.18	0.00	0.59	6.24	511	59
30	0.50	4.6	-12.8	17.4	0.29	0.09	0.56	5.63	460	62
35	0.47	0.8	-15.3	16.1	0.96	0.51	0.70	6.38	430	49
40	0.25	3.4	-12.4	15.8	1.93	0.74	0.58	7.44	366	49

GRAND BANKS 1984

LAT 43°49.5'N LONG. 49°05.7'W DATE 16.04.84 INCUB. TIME 6.05 HRS

Z	P	OXYGEN			NO_3	SiO_3	PO_4	CHL	CARBON	NITROGEN
		Pg	Pn	Pr						
5	5.66	39.7	32.2	7.5	1.22	0.22	0.13	10.11	991	90
10	2.75	31.8	21.4	10.4	0.36	0.14	0.13	11.15	930	93
15	1.41	6.7	6.8	-0.1	0.28	0.04	0.15	10.50	814	78
20	2.02	12.5	1.7	9.9	2.14	0.55	0.29	18.94	1057	123
25	0.93	4.7	5.2	-1.5	2.20	2.47	0.49	12.84	757	97
30	0.95	7.2	-2.7	9.9	3.25	2.82	0.46	11.02	581	55
35	0.49	5.1	-15.2	20.4	3.65	3.83	0.45	7.78	455	63
40	0.23	3.4	0.6	2.9	4.31	4.72	0.47	6.87	347	49

Incident Radiation

Photosynthetically Active Radiation (P.A.R.) and Total Radiation are in W m^{-2} for hour ending at hour indicated. All times are A.S.T.

PAR
GRAND BANKS
April 1984

TIME	11/4	12/4	13/4	14/4	15/4	16/4	17/4
0600	-	22	17	33	30	31	26
0700	-	74	58	87	90	72	69
0800	97	136	114	214	149	152	148
0900	121	114	91	324	177	193	175
1000	114	132	39	386	200	255	167
1100	271	85	289	455	440	205	122
1200	350	121	288	485	459	245	203
1300	282	146	218	457	362	230	251
1400	218	87	136	334	354	192	134
1500	147	94	116	246	241	124	135
1600	156	49	69	183	139	73	68
1700	95	25	43	103	90	54	-
1800	18	3	13	21	11	15	-

TOTAL

TIME	11/4	12/4	13/4	14/4	15/4	16/4	17/4
0600	-	28	22	44	39	41	36
0700	-	93	71	119	122	96	94
0800	120	172	143	306	201	203	207
0900	143	136	113	451	232	254	237
1000	131	157	42	520	233	339	218
1100	340	96	373	616	512	264	149
1200	441	141	362	647	553	318	261
1300	349	174	266	617	425	298	330
1400	264	101	164	441	433	252	169
1500	181	112	142	333	283	160	175
1600	210	59	85	235	130	94	84
1700	142	30	55	124	21	71	-
1800	23	4	18	25	-	19	-
1900							

Light Saturation Data and Related Biomass and Nutrient Measurements

P = mg C m^{-3} h^{-1} $(mg\ Chl)^{-1}$

I = W m^{-2}

P_s = mg C mg Chl^{-1} h^{-1}

α = mg C $(mg\ Chl)^{-1}$ h^{-1} w^{-1} m^{-2}

β = mg C $(mg\ Chl)^{-1}$ h^{-1} w^{-1} m^{-2}

Organic particulates are in mg m^{-3}. Inorganic nutrients are in mg at m^{-3}. The 90% confidence interval for P_s, α and β are shown in the closed brackets below the estimates for each parameter.

GRAND BANKS 1984

LAT 45 41.20'N LONG 54 51.80'W DATE 11/04/84 DEPTH 55 M

I	P	I	P	I	P	I	P
458	3.25	375	3.00	331	3.16	295	3.34
247	3.11	223	3.06	191	2.99	175	3.16
124	3.47	108	3.29	102	3.14	90	2.95
84	3.31	69	2.81	67	3.60	63	2.53
45	3.02	38	2.52	34	2.19	29	2.37
26	1.77	24	1.57	24	1.30	12	.99
9	.68	7	.48	5	.42	4	.28
3	.17	2	.16	2	.14	1	.10
1	.06	.8	.04	.7	.05	.5	.04
.4	.03	.4	.02	.4	.03	.3	.02
.2	.03	.2	.02				

PARAMETER VALUES

PS :	ALPHA :	BETA :
3.46	.105	.0010
(3.29, 3.63)	(.098, .112)	(.0003, .0017)

SAMPLE TEMP	1.8 C	INCUBATION TEMP	2.3 C
CHLOROPHYLL :	4.55	NITRATE :	2.90
CARBON :	375	SILICATE :	3.53
NITROGEN :	43	PHOSPHATE :	.60

GRAND BANKS 1984

LAT 43 54.30'N LONG 49 8.80'W DATE 12/04/84 DEPTH 10 M

I	P	I	P	I	P	I	P
383	1.95	319	2.86	279	4.19	251	3.95
215	4.46	191	4.42	179	4.19	115	4.45
100	4.19	89	4.12	79	4.22	71	3.88
62	3.61	55	3.79	47	4.16	37	3.10
33	2.36	26	2.83	25	2.64	19	2.46
16	1.93	9	1.63	6	1.09	6	.59
4	.90	3	.42	2	.14	2	.33
2	.14	1	.08	1	.06	.8	.04
.7	.01	.5	.03	.4	.04	.4	.02
.4	.00	.3	.01	.3	.01		

PARAMETER VALUES

PS : 6.28 (5.56, 7.00)

ALPHA : .134 (.125, .144)

BETA : .0134 (.0089, .0178)

SAMPLE TEMP .7 C

INCUBATION TEMP 4.8 C

CHLOROPHYLL	9.11	NITRATE	.86
CARBON	744	SILICATE	.14
NITROGEN	98	PHOSPHATE	.34

GRAND BANKS 1984

LAT 43 54.30'N LONG 49 8.80'W DATE 13/04/84 DEPTH 5 M

I	P	I	P	I	P	I	P
335	1.19	295	1.37	263	1.46	235	1.38
199	1.39	187	1.49	171	1.37	109	1.39
93	1.31	82	1.26	73	1.31	69	1.17
63	1.41	60	1.30	44	1.47	37	1.14
31	1.10	29	1.19	26	.87	20	.62
16	.73	12	.41	8	.33	7	.25
5	.21	4	.10	3	.09	2	.05
2	.06	1	.03	.9	.02	.8	.02
.8	.05	.6	.01	.6	.02	.5	.01
.4	.01	.4	.01	.3	.01	.3	.01

PARAMETER VALUES

PS : 1.50 (1.42, 1.59)

ALPHA : .055 (.051, .059)

BETA : .0006 (.0002, .0011)

SAMPLE TEMP	.6 C	INCUBATION TEMP	.8 C
CHLOROPHYLL :	13.23	NITRATE :	.77
CARBON :	866	SILICATE :	.77
NITROGEN :	76	PHOSPHATE :	1.30

GRAND BANKS 1984

LAT 43 57.20'N LONG 49 7.50'W DATE 14/04/84 DEPTH 20 M

I	P	I	P	I	P	I	P
447	1.05	347	.81	299	.83	267	.86
239	.74	211	.71	187	.89	167	.89
140	.98	110	.96	98	.87	91	.86
81	.86	73	.86	65	.89	58	.89
46	.92	39	.80	34	.82	30	.58
28	.56	20	.44	16	.48	11	.31
8	.18	6	.15	5	.15	3	.07
2	.04	2	.03	2	.03	1	.02
1	.01	.9	.00	.9	.01	.7	.01
.6	.00	.6	.00	.4	.00	.3	.00

PARAMETER VALUES

PS : .93 (.86, .97)

ALPHA : .038 (.034, .041)

BETA : .0002 (.0000, .0004)

SAMPLE TEMP .8 C

INCUBATION TEMP 1.0 C

CHLOROPHYLL : 12.20

CARBON : 838

NITROGEN : 72

NITRATE : .30

SILICATE : .22

PHOSPHATE : .38

GRAND BANKS 1984

LAT 43 57.20'N LONG 49 7.50'W DATE 14/04/84 DEPTH 15 M

I	P	I	P	I	P	I	P
347	.71	299	.65	267	.60	239	.67
211	.68	187	.68	167	.69	110	.70
98	.65	91	.61	81	.72	73	.57
65	.64	58	.64	39	.57	34	.60
30	.50	28	.42	20	.42	16	.36
11	.24	8	.11	6	.14	5	.13
3	.06	2	.04	2	.03	2	.02
1	.01	1	.01	.9	.01	.9	.00
.7	.00	.6	.00	.5	.00	.3	.00

PARAMETER VALUES

PS : .69 (.66, .72)

ALPHA : .028 (.026, .030)

BETA : .0001 (.0000, .0002)

SAMPLE TEMP	.8 C	INCUBATION TEMP	1.0 C
CHLOROPHYLL :	12.07	NITRATE :	.31
CARBON :	653	SILICATE :	.21
NITROGEN :	60	PHOSPHATE :	.39

GRAND BANKS 1984

LAT 43 53.60'N LONG 49 5.60'W DATE 15/04/84 DEPTH 30 M

I	P	I	P	I	P	I	P
454	1.59	339	1.58	279	1.69	235	1.59
207	1.63	187	1.52	171	1.55	167	1.66
132	1.60	112	1.62	94	1.49	85	1.50
75	1.51	65	1.48	57	1.44	54	1.51
44	1.58	36	1.39	33	1.34	27	1.16
24	1.12	19	.97	16	.92	12	.58
8	.42	7	.30	5	.24	4	.15
3	.12	2	.10	2	.13	2	.04
1	.02	1	.05	.9	.02	.8	.02
.7	.06	.6	.02	.6	.04	.5	.01
.5	.01	.4	.01				

PARAMETER VALUES

PS : 1.61 (1.57, 1.65)

ALPHA : .073 (.070, .077)

BETA : .0000 (-.0002, .0002)

SAMPLE TEMP -.5 C

INCUBATION TEMP 1.2 C

CHLOROPHYLL : 7.45

CARBON : 703

NITROGEN : 65

NITRATE : .29

SILICATE : .09

PHOSPHATE : .56

GRAND BANKS 1984

LAT 43 53.60'N LONG 49 5.60'W DATE 15/04/84 DEPTH 25 M

I	P	I	P	I	P	I	P
339	1.62	279	2.04	235	2.28	207	2.32
187	1.81	171	2.08	167	2.03	132	2.38
112	2.04	94	2.25	85	2.34	75	2.04
65	1.94	57	1.91	54	2.10	44	2.19
36	1.62	33	1.82	27	1.74	24	1.51
19	1.32	16	1.12	12	.84	8	.64
7	.62	5	.33	4	.22	3	.15
2	.12	2	.17	2	.10	1	.04
1	.03	.9	.02	.8	.03	.7	.01
.6	.00	.6	.03	.5	.01	.4	.01

PARAMETER VALUES

PS :	ALPHA :	BETA :
(2.32, 2.58)	(.089, .101) .095	(.0013, .0028) .0020

SAMPLE TEMP	.0 C	INCUBATION TEMP	1.0 C
CHLOROPHYLL :	11.53	NITRATE :	1.18
CARBON :	676	SILICATE :	.00
NITROGEN :	71	PHOSPHATE :	.59

GRAND BANKS 1984

LAT 43 46.50'N LONG 49 1.00'W DATE 16/04/84 DEPTH 15 M

I	P	I	P	I	P	I	P
339	2.01	279	1.77	235	1.85	207	1.87
187	1.63	171	1.89	167	1.77	112	1.87
94	1.86	85	1.97	75	1.79	65	1.92
57	1.87	54	1.32	36	1.76	33	1.51
27	1.37	24	1.35	19	1.05	16	.88
12	.61	8	.54	7	.39	5	.24
4	.16	3	.10	2	.08	2	.05
2	.03	1	.04	1	.01	.9	.02
.8	.03	.7	.00	.6	.00	.6	.00
.5	.04	.4	.00				

PARAMETER VALUES

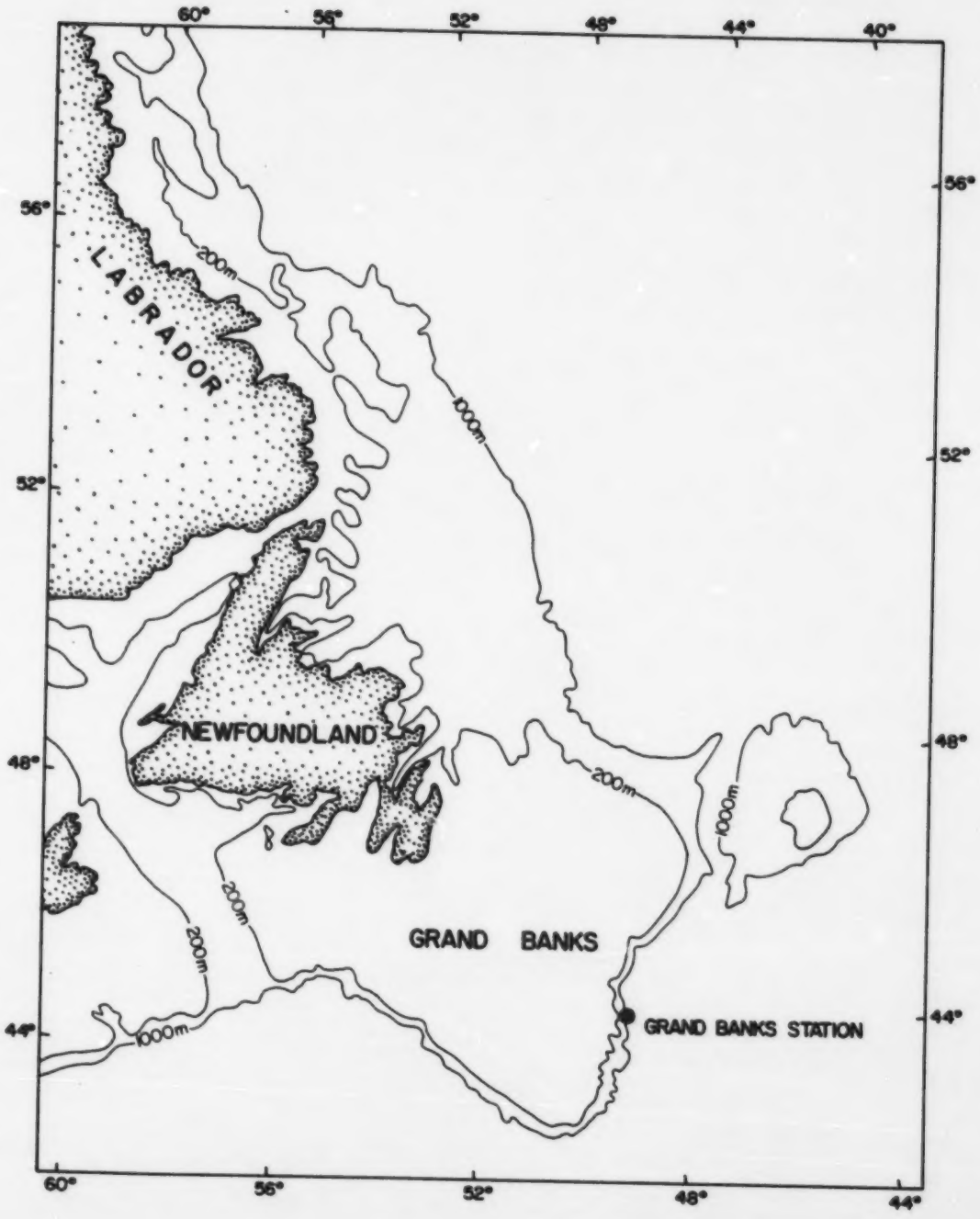
PS : 1.95 (1.85, 2.05)

ALPHA : .079 (.073, .084)

BETA : .0003 (-.0002, .0009)

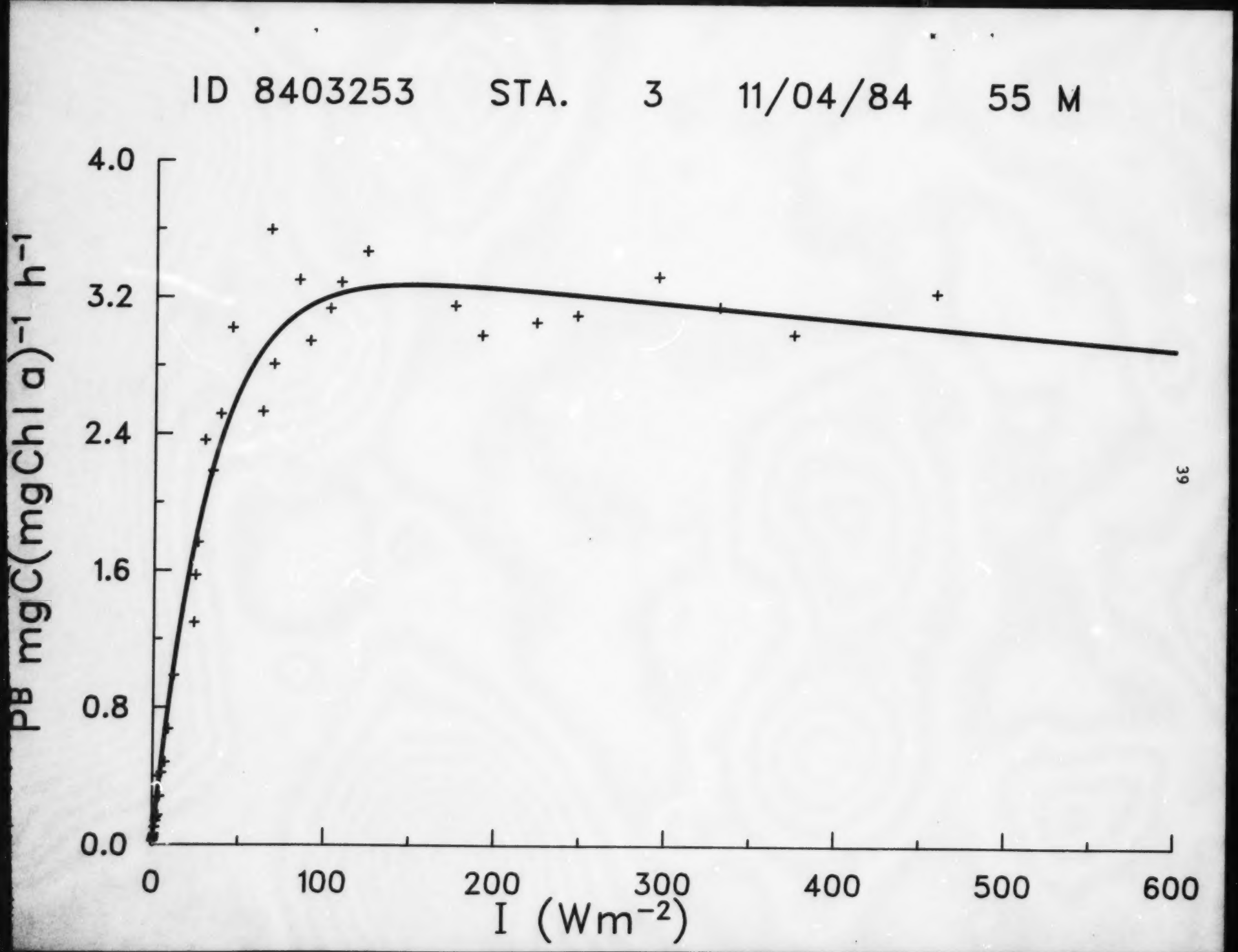
SAMPLE TEMP	.0 C	INCUBATION TEMP	1.2 C
CHLOROPHYLL :	12.71	NITRATE :	.28
CARBON :	574	SILICATE :	.04
NITROGEN :	58	PHOSPHATE :	.15

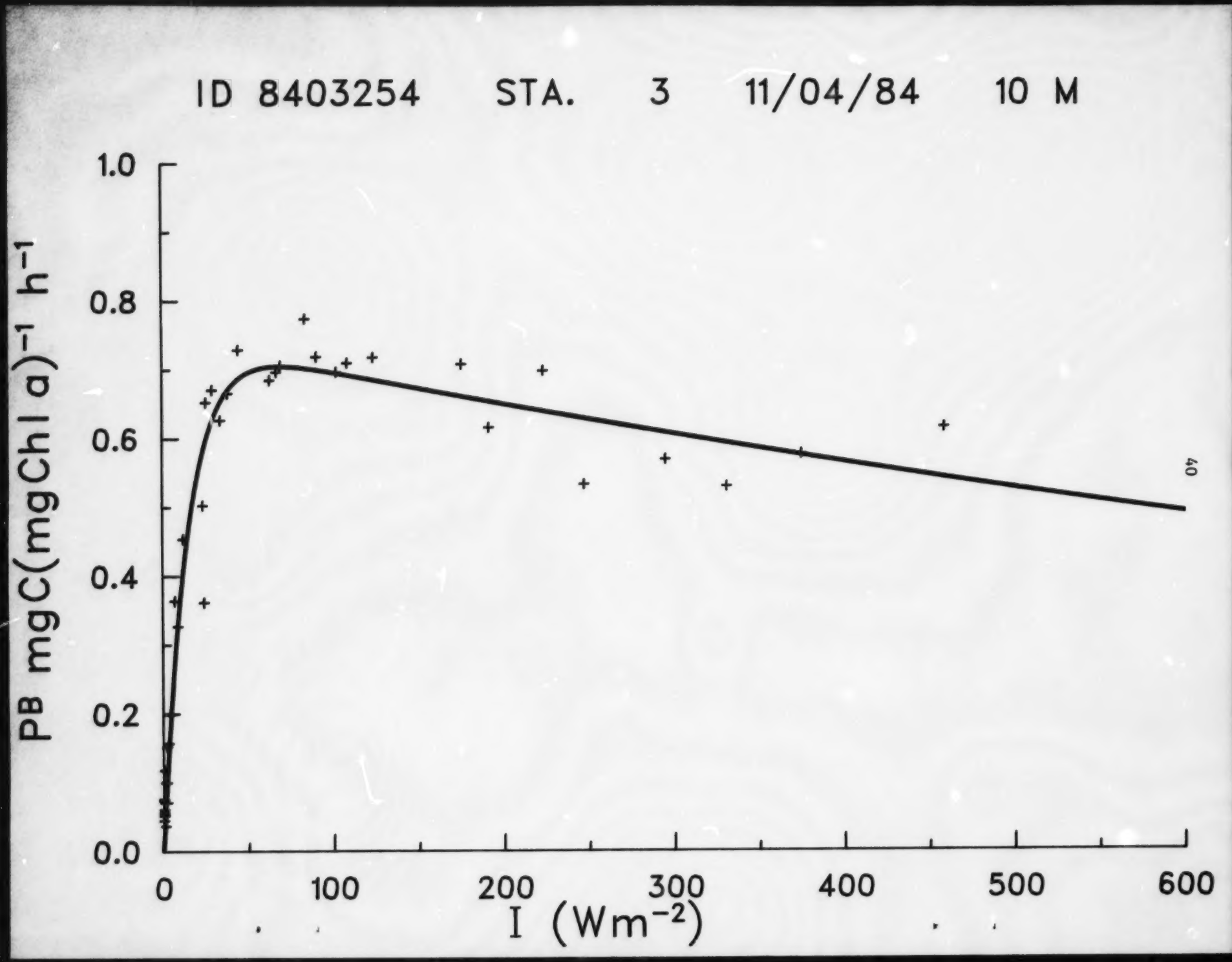
Location of sampling station on the Grand Banks

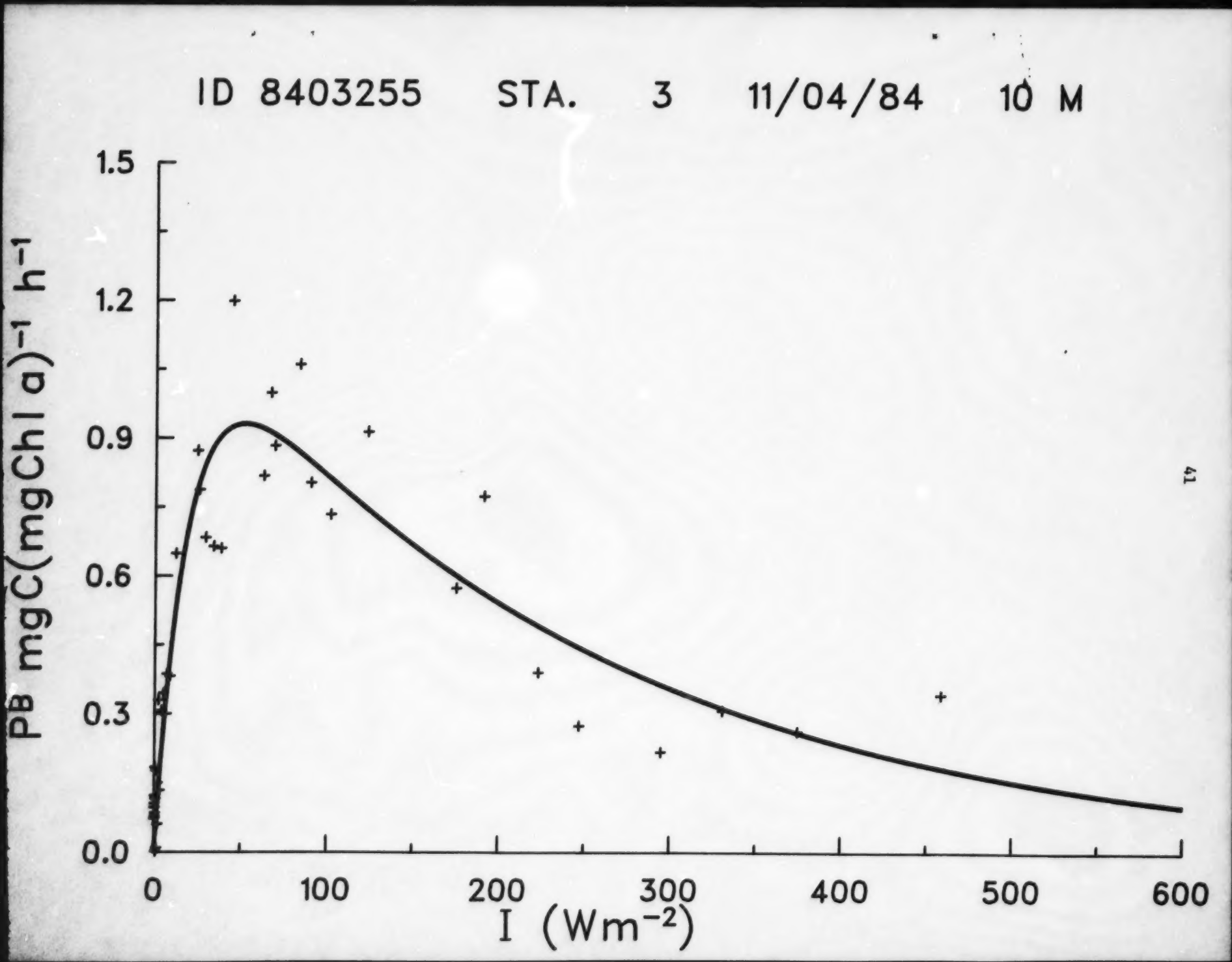


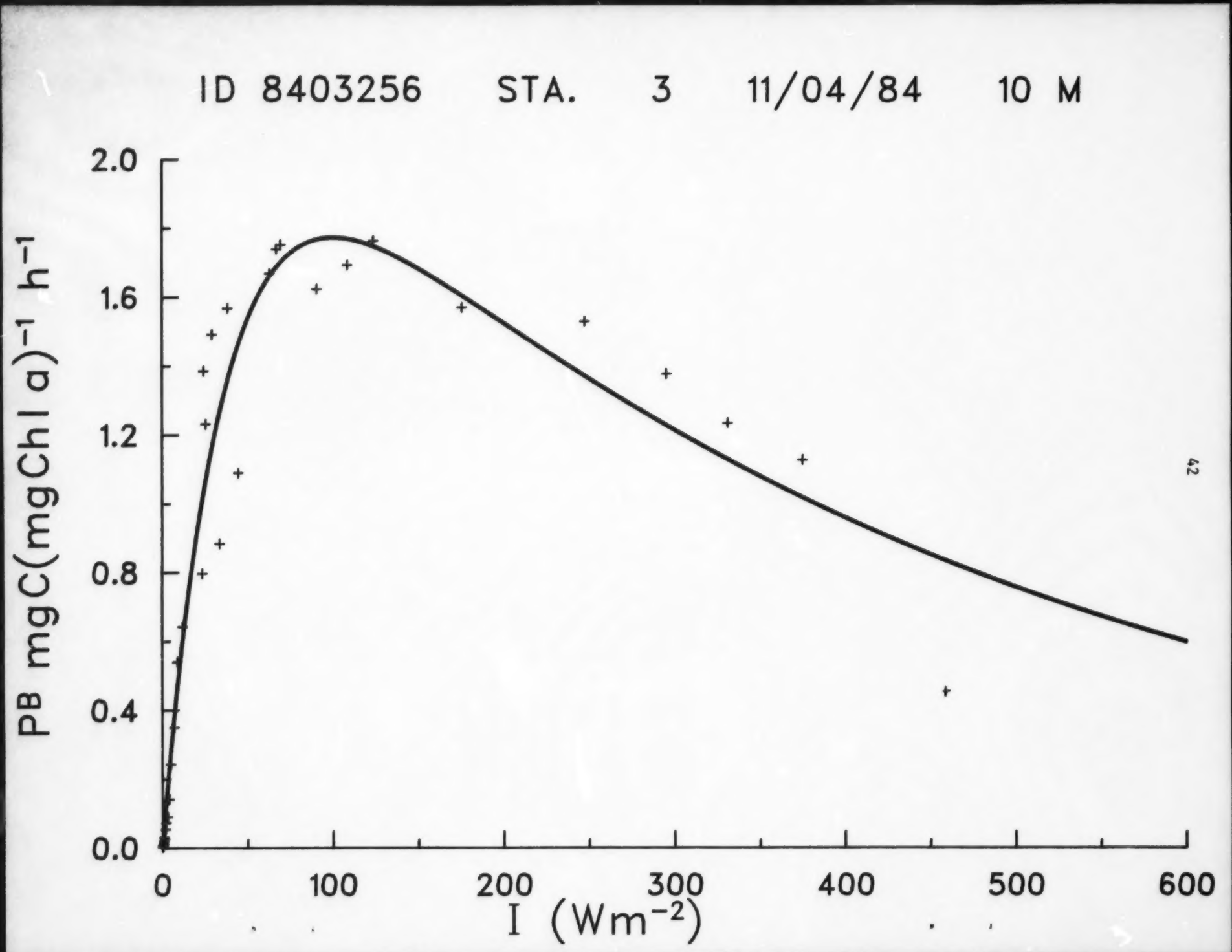
Location of station occupied between April 9 and 19, 1984 on the Grand Banks.

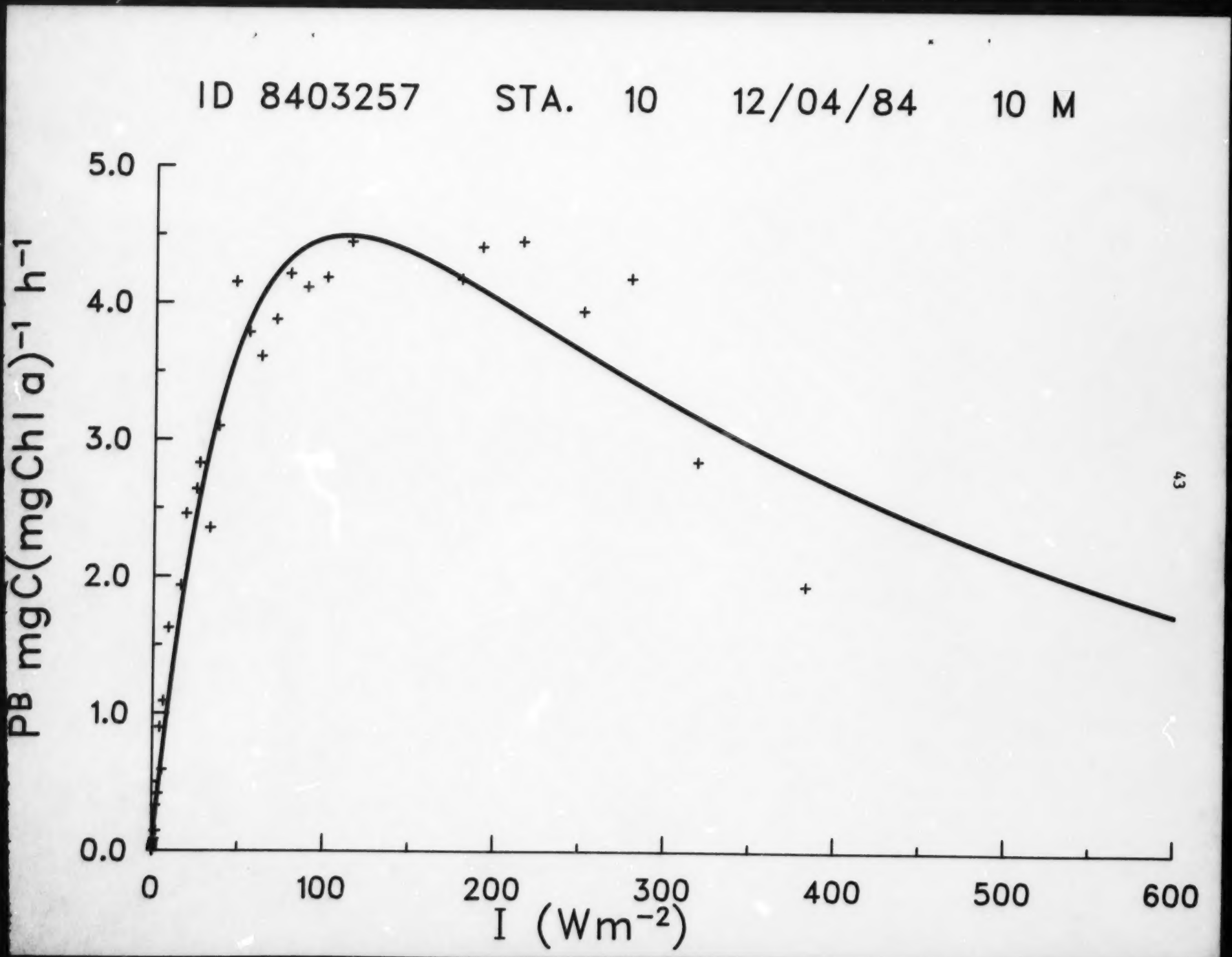
Solid line fit to observed PI data

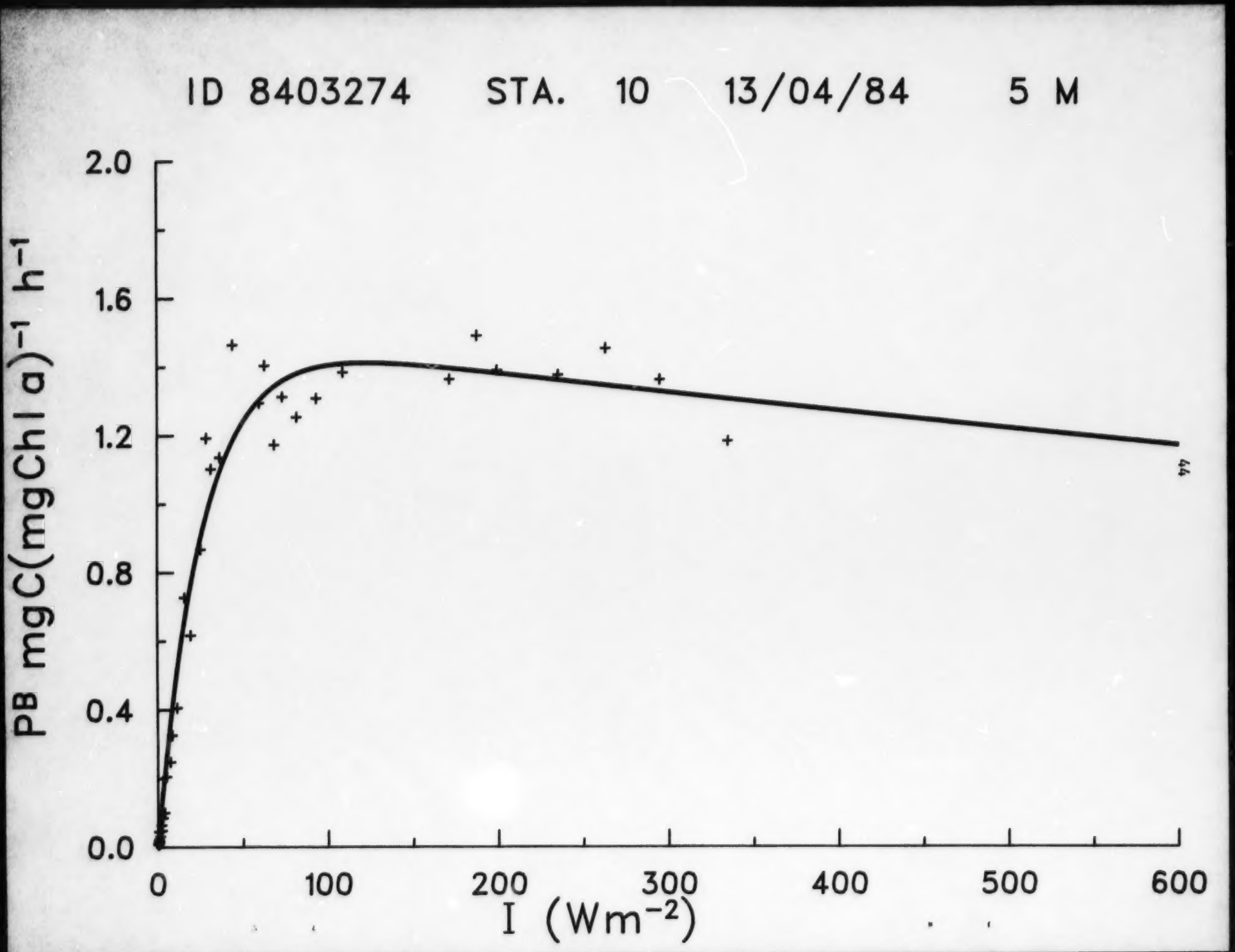

ID 8403253 STA. 3 11/04/84 55 M
4.0
3.2
2.4
1.6
0.8
0.0
PB mgC(mgChl a)$^{-1}$ h^{-1}
0
100
200
300
400
500
600
I (Wm^{-2})
39

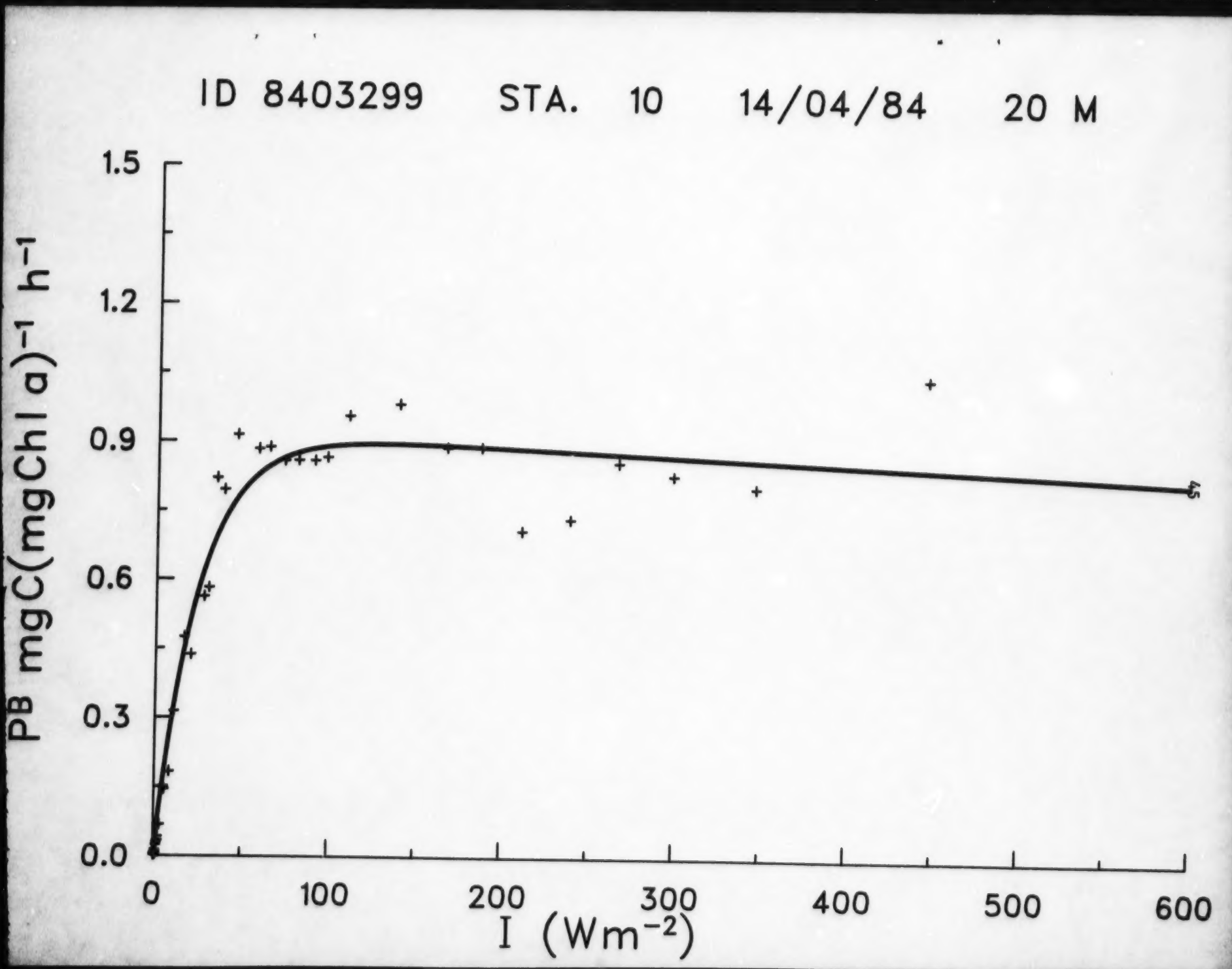

ID 8403254 STA. 3 11/04/84 10 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500
600
I (Wm^{-2})
40

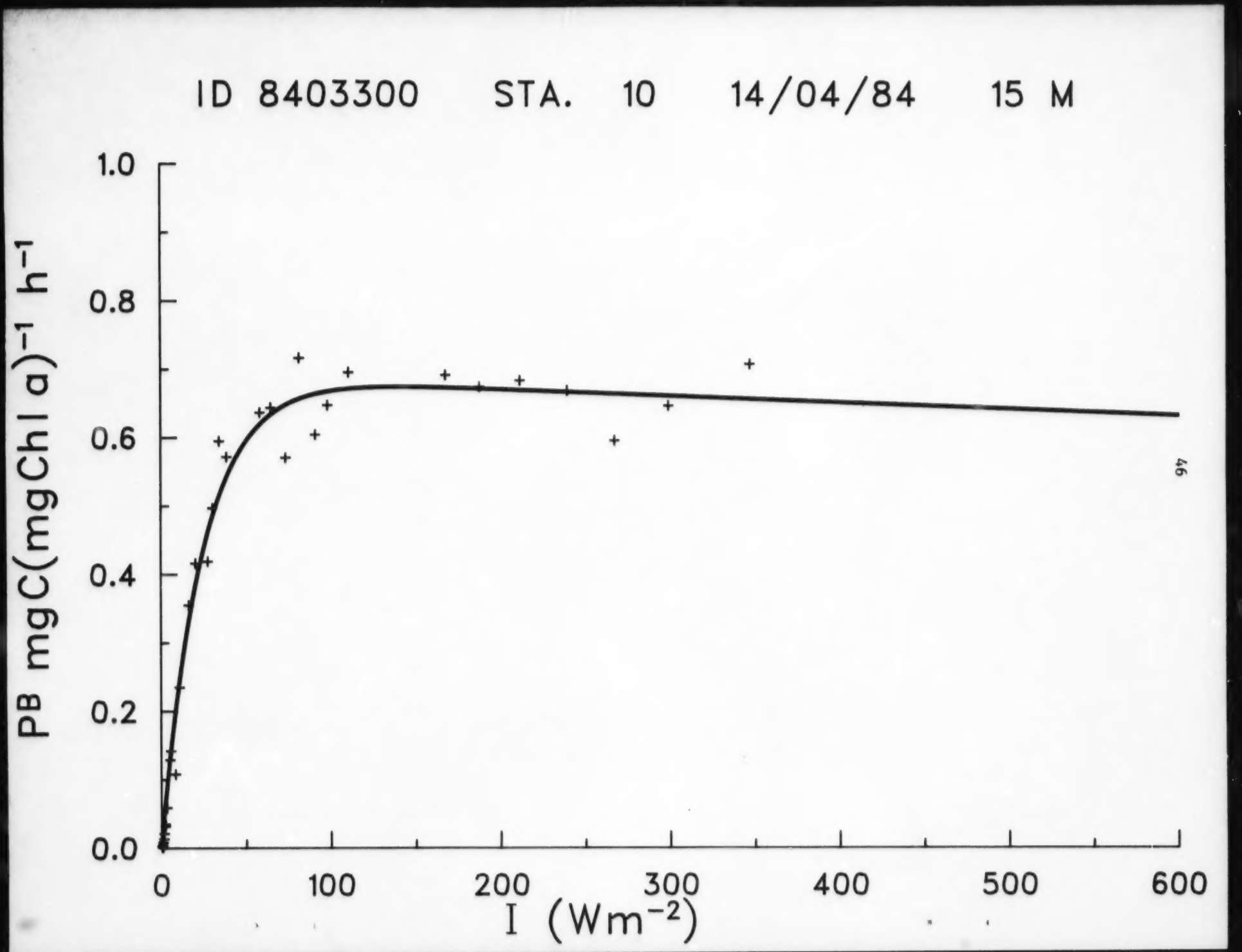

ID 8403255 STA. 3 11/04/84 10 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
1.5
1.2
0.9
0.6
0.3
0.0
0
100
200
300
400
500
600
I (Wm^{-2})

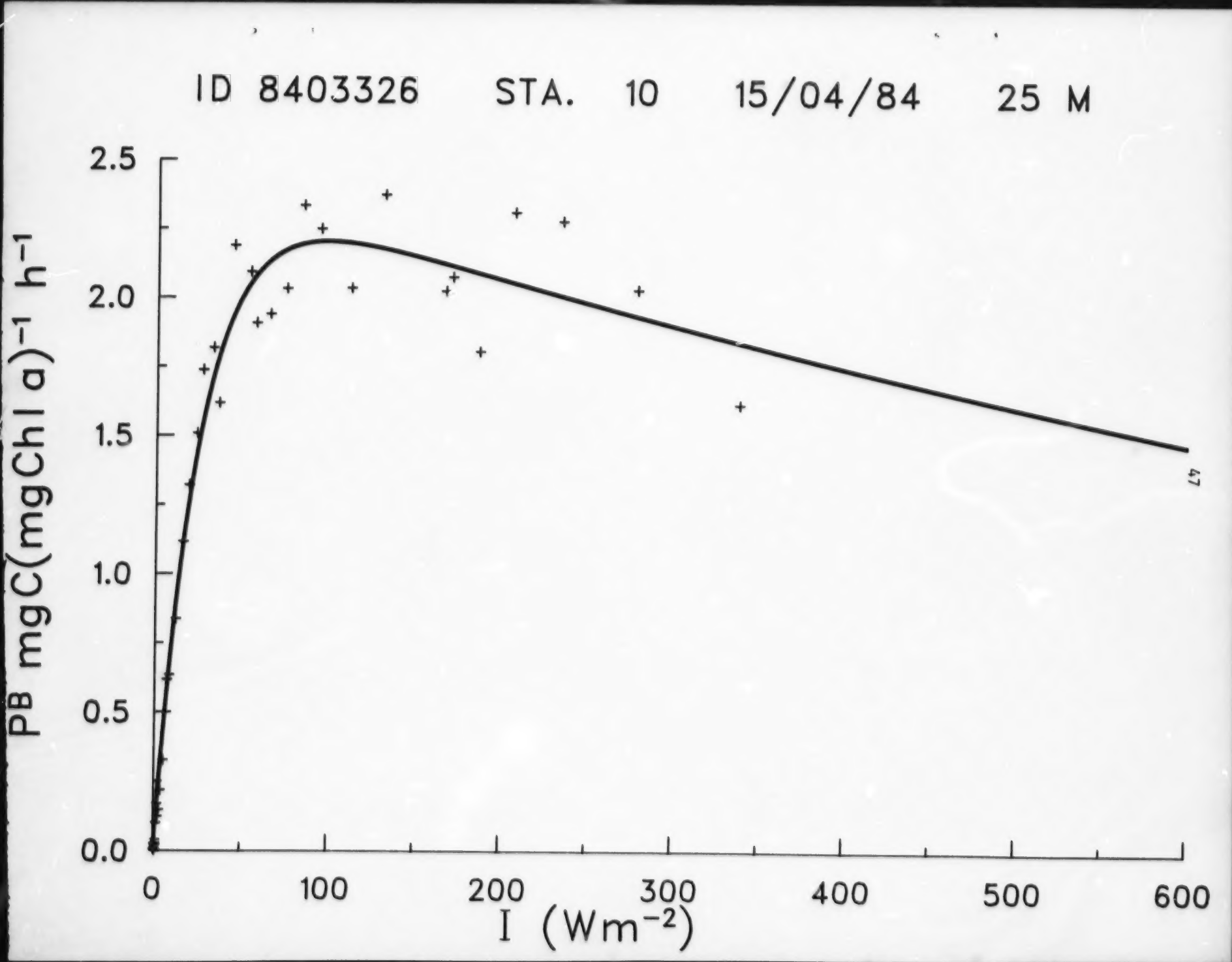

ID 8403256 STA. 3 11/04/84 10 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
2.0
1.6
1.2
0.8
0.4
0.0
0
100
200
300
400
500
600
I (Wm^{-2})
42

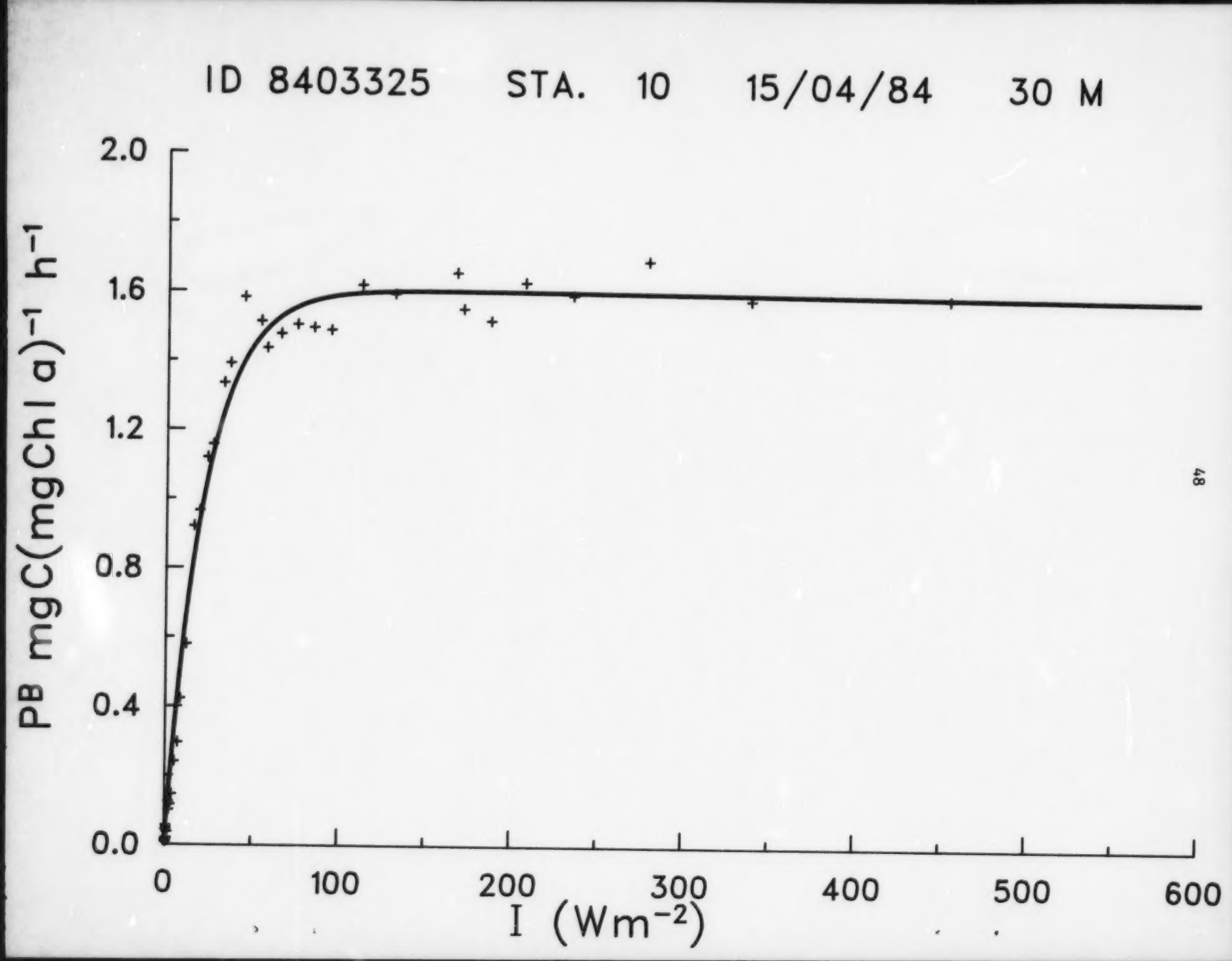

ID 8403257 STA. 10 12/04/84 10 M
5.0
4.0
3.0
2.0
1.0
0.0
PB mgC(mgChl a)$^{-1}$ h^{-1}
0
100
200
300
400
500
600
I (Wm^{-2})

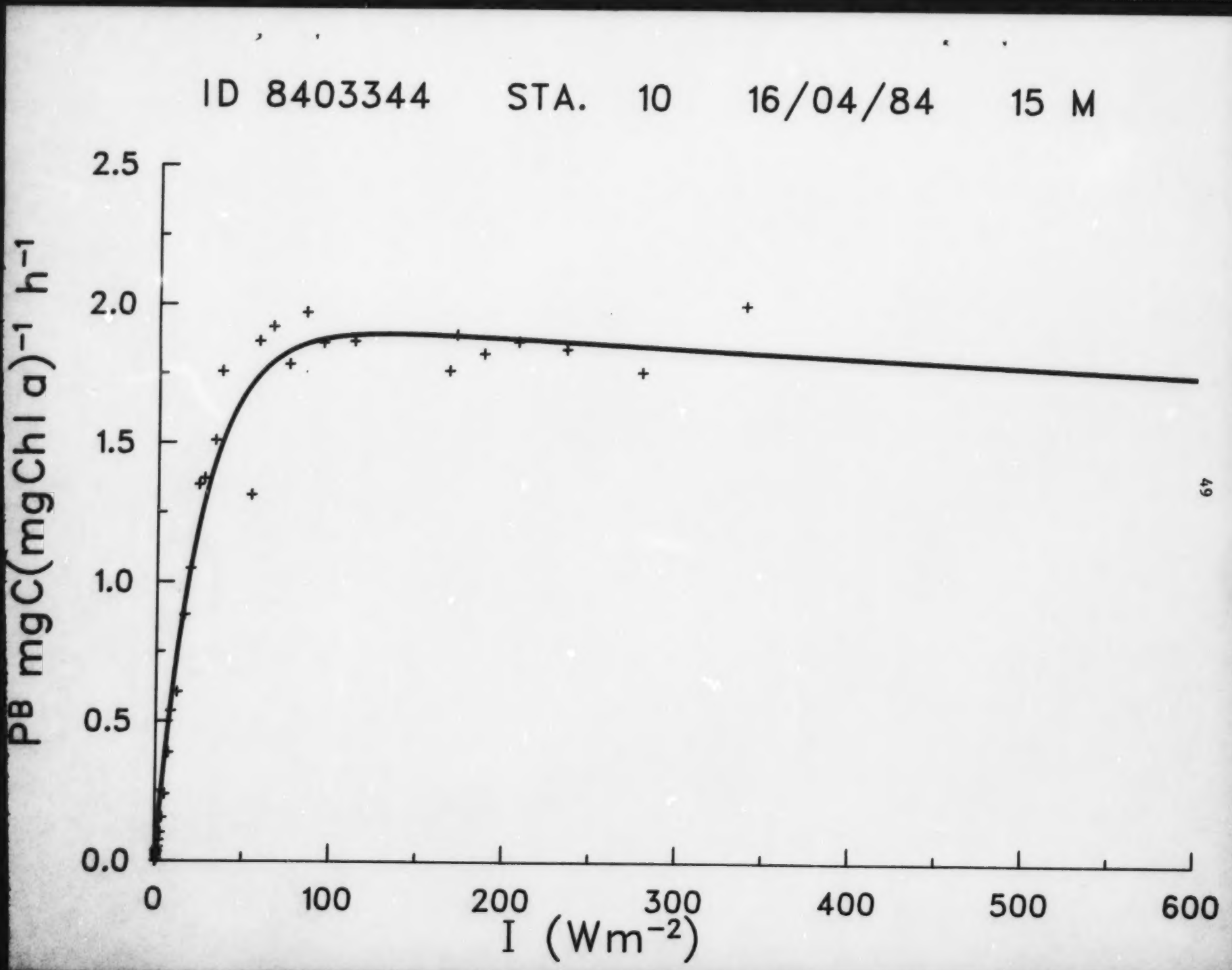

ID 8403274 STA. 10 13/04/84 5 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
2.0
1.6
1.2
0.8
0.4
0.0
0
100
200
300
400
500
600
I (Wm^{-2})


ID 8403299 STA. 10 14/04/84 20 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
1.5
1.2
0.9
0.6
0.3
0.0
0
100
200
300
400
500
600
I (Wm^{-2})


ID 8403300 STA. 10 14/04/84 15 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500
600
I (Wm^{-2})
46


ID 8403326 STA. 10 15/04/84 25 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
400
500
600
I (Wm^{-2})
47


ID 8403325 STA. 10 15/04/84 30 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
2.0
1.6
1.2
0.8
0.4
0.0
0
100
200
300
400
500
600
I (Wm^{-2})
48


ID 8403344 STA. 10 16/04/84 15 M
PB mgC(mgChl a)$^{-1}$ h^{-1}
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
400
500
600
I (Wm^{-2})
49